

Focus on the COVID-2019 Novel Coronavirus Infection

The Many Faces of COVID-19 – Spectrum of Imaging Manifestations

Fernando Kay, MD, PhD (<https://orcid.org/0000-0002-9467-2013>)

Suhny Abbara, MD, FACR, MSCCT (<https://orcid.org/0000-0003-2552-7362>)

From the Department of Radiology, UT Southwestern Medical Center, 5323 Harry Hines Blvd, Dallas, TX 75390-9316. **Address correspondence to:**
fernando.kay@utsouthwestern.edu

On January 30, 2020, the International Health Regulations Emergency Committee concluded that the outbreak of 2019 novel coronavirus (COVID-19, formerly 2019-nCoV) acute respiratory disease reached the status of a Public Health Emergency of International Concern (1).

The events that culminated in this global health care crisis had a modest origin in a fish and wild animal market commercializing live animals as poultry, bats, marmots, and snakes in the city of Wuhan, China (2).

At the time of writing of this article, the death toll from COVID-19 is at 1368 individuals and has surpassed that from the 2003 SARS outbreak. Today, there are 46,550 confirmed cases of COVID-19, 447 of which are in 24 countries outside of China. Only 1 death has occurred so far outside of China according to Situation Report 24 from the World Health Organization (3). In the United States, The Centers for Disease Control and Prevention has been monitoring this outbreak and numbers published February 7, 2020 reveal 443 individuals under investigation across 42 states and territories since January 21, 2020, with 15 confirmed cases (4).

VISIT...

LANZAROTE
Caliente.COM

The spotlight of this *Radiology: Cardiothoracic Imaging* issue exposes the wider spectrum of radiologic manifestations of the COVID-19 acute respiratory disease that can be encountered on images of the chest. On this issue, Ng et al (5) examine the clinical and radiologic presentation of 21 patients with confirmed COVID-19 from Chinese centers in Shenzhen and Hong Kong. They also put their findings into perspective and compare with imaging studies from other Chinese centers obtained by a systematic review of the emerging literature (6-9). The article demonstrates the spectrum of radiologic presentations and illustrates the growing role of CT in evaluation of patients with COVID-19 when compared to past coronavirus outbreak. The most common findings expected on chest imaging are ground-glass opacities or consolidation in a multilobar and peripheral distribution (5).

However, despite the continuous crystallization of this general picture of COVID-19, the granular analysis reveals a plethora of imaging manifestations, which is perhaps more diverse than anticipated. This is reflected in the large number of case reports with very interesting aspects recently submitted to this journal. For example, Kong and Agarwal (10) report a series of three unrelated cases of COVID-19 pneumonia presenting with a spectrum of findings on chest radiograph and CT, varying from the commonly seen ground-glass opacities and consolidation, to patterns that include crazy paving and reversed halo, suggesting organizing pneumonia as the underlying mechanism of lung injury (11, 12). In another report, Wu et al (13) show the temporal evolution on CT of a patient with COVID-19 infection, also presenting with radiologic findings resembling organizing pneumonia. It is noteworthy to mention that organizing pneumonia was described as the hallmark of another coronavirus infection outbreak occurring in 2012, with epicenter identified in Saudi Arabia, known as the Middle East Respiratory Syndrome (MERS-CoV) (14).

Viral pneumonias have been frequently associated with nodules on CT (15); however, the general picture of COVID-19 seems to exclude nodules as a frequent occurrence. An interesting report by Li et al (16) describes the case of a young woman with COVID-19 presenting with a single right upper lobe nodule with the halo sign. A review of the results published by Chung et al (8) reveals that rounded lung opacities can be present in up to 33% of the chest CT of symptomatic patients with COVID-19. Although it was initially thought to be associated with perilesional hemorrhage in angioinvasive fungal infections or hypervascular metastases (17), the halo sign can also be present in pneumonias caused by herpes simplex, varicella, cytomegalovirus, and Epstein-Barr viruses (15). Currently, the main pathological drivers for each radiologic pattern (eg, ground glass, consolidation, nodules, halo sign, etc) are unknown. As the knowledge about COVID-19 continues to advance, future studies will hopefully shed light on the histopathologic findings in this emerging viral infection, which in turn could result in better understanding of the various radiologic observations.

As the outbreak continues to spread worldwide, attention has shifted toward determinants of clinical manifestation and disease severity. For example, in a thought-provoking report, Liu et al (18) illustrate the spectrum of severity within a familial cluster of husband, wife, and son infected with COVID-19, varying from a normal study (obtained after confirmed infection but prior to onset of fever), to subtle centrilobular nodules, and the more common picture with multifocal ground-glass opacities. On the other end of the spectrum, Qian et al (19) epitomize the unfortunate outcome of severe pneumonia attributed to COVID-19 in a worker of the Huanan seafood market during the dawn of the outbreak. This wide spectrum of disease severity is a conundrum that needs further investigation. Recent observational studies have shown that older males with comorbidities

may present a risk group for the development and increased severity of COVID-19 pneumonia (6, 20). As the disease outbreak affects a larger population each day, it is crucial to develop strategies for protecting those at increased risk for worse clinical outcomes.

New data about the COVID-19 continues to emerge, and will, hopefully, facilitate the diagnostic and preventive measures for containing and minimizing the impacts of this international health emergency on public health. This focused issue of *Radiology: Cardiothoracic Imaging* seeks to raise awareness for this disease among the imaging community, illuminating the spectrum of disease under the microscope. As the picture becomes clearer, it is time for the scientific community to move to the next level, focusing efforts in elucidating the radiologic-pathologic correlation, determining potential imaging predictors of outcomes, and investigating the role of imaging for guidance of therapy.

References

- 1) World Health Organization. Statement on the second meeting of the International Health Regulations (2005) Emergency Committee regarding the outbreak of novel coronavirus (2019-nCoV). [https://www.who.int/news-room/detail/30-01-2020-statement-on-the-second-meeting-of-the-international-health-regulations-\(2005\)-emergency-committee-regarding-the-outbreak-of-novel-coronavirus-\(2019-ncov\)](https://www.who.int/news-room/detail/30-01-2020-statement-on-the-second-meeting-of-the-international-health-regulations-(2005)-emergency-committee-regarding-the-outbreak-of-novel-coronavirus-(2019-ncov))
- 2) Lu H, Stratton CW, Tang YW. Outbreak of pneumonia of unknown etiology in Wuhan China: the mystery and the miracle [published January 16, 2020]. J Med Virol. 2020.
- 3) Novel Coronavirus(2019-nCoV) Situation Report – 24.
https://www.who.int/docs/default-source/coronaviruse/situation-reports/20200213-sitrep-24-covid-19.pdf?sfvrsn=9a7406a4_4

- 4) 2019 Novel Coronavirus (2019-nCoV) in the U.S.
<https://www.cdc.gov/coronavirus/2019-ncov/cases-in-us.html>
- 5) Ng MY, Lee EYP, Yang, J, et al. Imaging Profile of the COVID-19 Infection: Radiologic Findings and Literature Review. Radiol Cardiothorac Imaging 2020;2(1):e200034.
- 6) Chen N, Zhou M, Dong X, Qu J, Gong F, Han Y, Qiu Y, Wang J, Liu Y, Wei Y, Xia J, Yu T, Zhang X, Zhang L. Epidemiological and clinical characteristics of 99 cases of 2019 novel coronavirus pneumonia in Wuhan, China: a descriptive study. Lancet. 2020 Jan 30. pii: S0140-6736(20)30211-7. doi: 10.1016/S0140-6736(20)30211-7. [Epub ahead of print] PubMed PMID: 32007143.
- 7) Huang, C., et al., Clinical features of patients infected with 2019 novel coronavirus in Wuhan, China. The Lancet.
- 8) Chung M, Bernheim A, Mei X, Zhang N, Huang M, Zeng X, Cui J, Xu X, Yang, Y, Fayad Z, Jacobi A, Li K, Li S, Shan H. CT Imaging Features of 2019 Novel coronavirus (2019-nCoV). Radiology, Published Online: Feb 4, 2020
<https://doi.org/10.1148/radiol.2020200230>
- 9) Song F, Shi N, Shan F, Zhang Z, Shen J, Lu H, Ling Y, Jiang Y, Shi. Emerging Coronavirus 2019-nCoV Pneumonia. Radiology, Published Online: Feb 6, 2020.
<https://doi.org/10.1148/radiol.2020200274>
- 10) Kong W, Agarwal PP. Chest Imaging Appearance of COVID-19 Infection. Radiol Cardiothorac Imaging 2020;2(1):e200028.
- 11) Rossi SE, Erasmus JJ, Volpacchio M, Franquet T, Castiglioni T, McAdams HP. "Crazy-paving" pattern at thin-section CT of the lungs: radiologic-pathologic overview. Radiographics. 2003 Nov-Dec;23(6):1509-19. Review. PubMed PMID: 14615561.
- 12) Kligerman SJ, Franks TJ, Galvin JR. From the radiologic pathology archives: organization and fibrosis as a response to lung injury in diffuse alveolar damage,

organizing pneumonia, and acute fibrinous and organizing pneumonia.

Radiographics. 2013 Nov-Dec;33(7):1951-75. doi: 10.1148/rg.337130057. Review.

PubMed PMID: 24224590.

- 13) Wu Y, Xie YL, Wang, X. Longitudinal CT Findings in COVID-19 Pneumonia: Case Presenting Organizing Pneumonia Pattern. Radiol Cardiothorac Imaging 2020;2(1):e200031.
- 14) Ajlan AM, Ahyad RA, Jamjoom LG, Alharthy A, Madani TA. Middle East respiratory syndrome coronavirus (MERS-CoV) infection: chest CT findings. AJR Am J Roentgenol. 2014 Oct;203(4):782-7. doi: 10.2214/AJR.14.13021. Epub 2014 Jun 11. PubMed PMID: 24918624.
- 15) Franquet T. Imaging of pulmonary viral pneumonia. Radiology. 2011. Jul;260(1):18-39. doi: 10.1148/radiol.11092149. PubMed PMID: 21697307.
- 16) Li X, Zeng X, Liu B, Yu Y. COVID-19 Infection Presenting with CT Halo Sign. Radiol Cardiothorac Imaging 2020;2(1):e200026.
- 17) Pinto PS. The CT Halo Sign. Radiology. 2004 Jan;230(1):109-10. PubMed PMID: 14695389.
- 18) Liu T, Huang P, Liu H, et al. Spectrum of Chest CT Findings in a Familial Cluster of COVID-19 Infection. Radiol Cardiothorac Imaging 2020;2(1):e200025.
- 19) Qian L, Yu J, Shi H. Severe Acute Respiratory Disease in a Huanan Seafood Market Worker: Images of an Early Casualty. Radiol Cardiothorac Imaging 2020;2(1):e200033.
- 20) Wang D, Hu B, Hu C, Zhu F, Liu X, Zhang J, Wang B, Xiang H, Cheng Z, Xiong Y, Zhao Y, Li Y, Wang X, Peng Z. Clinical Characteristics of 138 Hospitalized Patients With 2019 Novel Coronavirus-Infected Pneumonia in Wuhan, China. JAMA. 2020 Feb 7. doi: 10.1001/jama.2020.1585. [Epub ahead of print] PubMed PMID: 32031570.